# ***WRITE UP***

The channel estimation scheme proposed in this work involves a two-stage approach aimed at accurately estimating the channel amplitude and identifying the positions of non-zero entries in the channel response. In the first stage, a Convolutional Neural Network (CNN) is employed to estimate the amplitude of the sparse channel response. Subsequently, in the second stage, the positions of non-zero entries are determined based on the amplitude information obtained in the first stage, followed by the calculation of the values of these non-zero entries.

**First Stage: Sparse Channel Amplitude Estimation**

Drawing inspiration from the remarkable performance of Deep Learning (DL) techniques across various domains, a CNN model is chosen to learn the mapping function from the limited measurement vector received at the Intelligent Reflecting Surface (IRS) to the amplitude of the sparse channel response, thereby enhancing the accuracy of identifying the positions of non-zero entries.

The framework based on the CNN architecture is outlined, involving a training process to obtain a well-trained CNN model. During the testing phase, the test data is fed into the well-trained CNN to predict the amplitude of the sparse channel response.

Formulating the problem of estimating the channel amplitude as a regression problem, the choice of DL model is crucial. In consideration of both model complexity and estimation performance, a classic CNN architecture is selected. The proposed CNN architecture comprises four convolutional layers followed by one fully connected layer.

- The first layer serves as the input layer.
- The second layer consists of a convolutional layer with 64 filters of size $7 \times 7$.
- The third layer is another convolutional layer with 32 filters of size $5 \times 5$.
- The fourth layer utilizes 16 filters of size $3 \times 3$.
- The fifth layer is a convolutional layer with two filters of size $1 \times 1$.
- Finally, the sixth layer employs a fully connected layer to flatten the output of the preceding convolutional layers.

All layers of the CNN incorporate the leaky rectified linear unit activation function. The proposed CNN model adopts an expanded scale of convolutional layers and employs relatively small convolutional kernels, enabling the network to focus more on the finer details of amplitude estimation.

Overall, the first stage of the channel estimation scheme leverages CNN-based regression to accurately estimate the amplitude of the sparse channel response, providing a solid foundation for subsequent stages of the estimation process.